Kingshill

POWER SUPPLIES

TECHNICAL DATA

'NS & NM' Series
I C Version

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THIS SPECIFICATION IS APPROVED
FOR USE IN THE CALIBRATION OF
COMPANY INSTRUMENTS. (9)
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BRITISH AIRCRAFT CORPORATION, STEVENAGE.

CIRCUIT DESCRIPTION AND OPERATING INSTRUCTIONS FOR KINGSHILL S & M SERIES STABILISED POWER SUPPLY BRICKS.

1. Circuit description.

Adjustments to suit the user's main voltage are obtained by using the appropriate tappings on the primary of the main transformer. The secondary consists of several windings which may be connected to give nominal R.M.S. outputs from 1 volt up to the maximum available in 1 volt increments. By using the lowest voltage that gives satisfactory operation for any given D.C. output, the dissipation in the unit is kept to a minimum. It is most important that attention should be paid to this point if the user decides to alter the output voltage of his units.

The main rectifier is MR2, the unregulated D.C. appearing across C2. The connection from C2 to the negative output terminal is made via the LINK on the output barrier strip; the uses to which this link may be put are described in para. 2. The connection from C2 to the positive output terminal is made via VT6, the series control element. VT6 consists of one or more power transistors in parallel, equal current sharing being ensured by emitter resistors R6. The stabilised voltage across the REF terminals is sampled by the potential divider R12, R8, RV2 and compared with the reference voltage across zener diode MR4 by the operational amplifier OA1. Any error in the sampled voltage appears amplified at the output of OA1 and is coupled via emitter followers VT4, VT5 and above 1 amp VT7, to the base of the series element VT6 in such a way as to reduce the error in the voltage across the reference terminals. The voltage across the reference terminals is therefore stabilised, and in 4 wire output usage (see para. 2) any voltage drop in the connecting wires between the OUT terminals and the load is absorbed by the power unit.

Protection afforded by the unit occurs in three stages.

(a) First stage constant current limiter. The voltage developed across R6 which is proportional to the load current is compared with a preset voltage across RV1. Under normal conditions the latter voltage is the greater of the two and biasses VT3 to cut-off. At a sufficiently high value of load current (determined by VR1 setting) VT3 becomes forward biassed and the drive from OA1 to VT4 is clamped to a constant value. Any attempt to increase the load current by reducing the load resistance results in a reduction of output voltage since the available load current is now fixed by VT3 action.

(b) Second stage re-entry. As the load resistance is progressively decreased the output voltage falls together with the voltage developed across VR1. This reduces the voltage required across R6 to forward bias VT3 so the load current falls to a value now determined by the voltage across VR1. When the load is a short circuit, the output voltage is zero and the voltage across VR1 is almost zero. The load current has also fallen to a value just sufficient to maintain VT3 forward biassed.

(c) Stage 3. This is independent of stages 1 and 2 being a fuse F1 which is included primarily to protect the major components from damage in the event of a catastrophic failure in any one of them.

A simple link change on the printed circuit board allows the current limiter to be changed to the "constant current" type. In this case the lower end of a suitably chosen value of R5c is connected to the anode of MR5 which maintains the preset voltage across RV1 at a fixed value independent of output voltage. Hence the limit current is constant as the output voltage falls during limiting action. It is necessary to ensure that VT6 cannot over dissipate during this overload (by increasing the size of VT6 or using some form of second stage protection) since generally the series element is not suitably rated for this type of protection at output voltages of more than a few volts.

Note that the 150 volt M series units are fitted with constant current limiters and the series element is suitably rated.

2. Mains voltage settings.

Mains connections to all standard modules are marked at the bottom of the front panel barrier strip as L.N.E. and the primary tappings on the mains transformer must be set to correspond with the user's mains voltage. These tappings are connected to clearly marked turret lugs on the mains transformer panel, a soldering iron being necessary if a change is required. Mains connections to the minimodule units should be made direct to turret lugs on the transformer panel. Units are set at 240V on despatch unless otherwise specified.

Most modules have twin transformer primaries of 5, 0, 100, 110, 120 volts for series or parallel connection, giving 100 to 125 and 200 to 250 volts in 5 volt increments. The $5\frac{1}{8}$" x 4" x $7\frac{1}{2}$" and smaller modules are normally supplied with a twin primary of 0, 110, 120 volts, (to provide for 110 volts or 240 volts input) but a single primary of 10, 0, 200, 220, 240 volts is available on request. A single primary of 5, 0, 100, 110, 120 volts can be supplied to special order.

3. Barrier strip connections OUT, REF, LINK.

Four-wire output is provided to allow the voltage drop in the connecting wires between the supply and the load to be absorbed by the supply. The voltage at the load itself is thus stabilised. If this form of connection is desired, the load should be connected to the + OUT and – OUT terminals of the unit using a wire gauge sufficient to carry the load current. The wire straps between the OUT and REF terminals are then removed and a wire taken from each REF terminal to the point on the load where the stabilised voltage is required, care being taken that the + OUT and + REF wires are joined to one side of the load, and the – OUT and – REF wires to the other. The voltage at the point where the REF wires join the load will thus be stabilised.
Note. On twin units with 4" wide panels, the reference terminals are miniature sockets and the wire straps are soldered at the rear of the panel.

The wires joined to the REF terminals carry only a few mA for voltage sensing and so may be of quite light gauge. Using this form of connection the wires carrying the current from the OUT terminals to the load need not be excessively heavy to minimise the voltage drop along them.

However, in many cases two-wire output is sufficient when the user will tolerate the connecting wire voltage drop to gain the convenience of two connecting wires only. In this case + OUT and + REF terminals are linked, the – OUT and – REF terminals are linked and the load is connected to + OUT and – OUT. The voltage across the terminals is now stabilised. Units are strapped for two-wire working at despatch.

The terminals mark LINK are provided for four reasons.

(a) The user may insert a remote fuse.

(b) The user may monitor current.

(c) The user may insert overload current alarm.

(d) These two terminals provide a source of constant current whose value is determined by the current in a load connected across the voltage terminals. See Para. 8.

4. Preset output voltage.

The voltage to which the unit has been preset is indicated by a stick on label on the front panel. The set volts control is mounted on this panel on the standard module, but on the mains terminal panel of the minimodule.

5. Alteration of output voltage.

The output voltage of a supply may be altered to any voltage between zero and the maximum by making at most three changes. These are :-

(a) The value of R8 to set the required voltage within the swing of the set volts control RV2.

(b) The value of R5 to set the current limiter coverage (RV1 preset)

(c) The correct mains transformer secondary tappings to suit the new output voltage. Failure to observe this requirement may result in the unit not stabilising, or its series transistors being overrun and possibly damaged.

6. Alteration of current limiter.

The current limiter is adjusted by RV1 a preset linear potentiometer which is located on the component printed circuit board of all units. The limiter may be set to operate at load currents down to about 20% of the maximum rating of the unit.

7. Mounting and ventilation.

The minimodule may be mounted in any position, but standard modules are restricted to mounting positions in which the main heatsinks are in a vertical plane. The brackets supplied with each unit allow mounting to be effected from any of its faces. Adequate ventilation must be allowed, and the ambient temperature of cooling air inside the unit most not exceed that specified.

NOTE. Standard modules may be mounted with heat sinks horizontal provided that a suitable unit derating is applied. The derating will necessarily depend upon the type of unit and the circumstances in which it is used.

8. Inductive loads and other reverse voltage sources.

It is recommended that a suitable diode or diodes be connected across the output of the supply to prevent reverse voltages from being applied. The diodes will conduct when an inductively loaded supply is switched off, and should have a continuous current rating at least equal to the unit maximum current rating. The cathode of the diode should be connected to the positive side of the supply.

9. Series operation.

Units may be used in series so long as no point in the circuit is at more than 350 volts above earth. Reverse voltage protection by diode is recommended as in 8 above as a safeguard in the event of short circuits between supplies. For example, if a 1 Amp unit and a 10 Amp unit are used in series and the output short-circuited the diode across one supply acts as a current path for the short circuit current of the other supply. The diode across the 1 Amp supply would have to carry 10 Amps if the large supply has a "constant current" form of limiter. This example shows why these diodes are not fitted as a matter of course during manufacture.

10. Operation in parallel.

There are two methods by which units may be operated in parallel. In both cases all units should first be set up to the required output voltage. An unlimited number of units can be used.

(a) Simple paralleling of outputs. Any units may be used together.

For two-wire operation the links between the output and reference terminals should remain on the units. All positive outputs should be joined together at one end of the load and all negative outputs should be joined together at the other end of the load. If the various output voltages differ drastically (by more than the regulation voltage change for the units), the unit with the highest setting will effectively deliver all the load current demand until its maximum current rating is reached. Until this occurs, the other units will be prevented from delivering any current, since from their point of view the output voltage is too high (although perhaps by only a few millivolts). Which results in a turn-off signal being applied to their series elements. As the load demand increases, the first unit eventually current limits and its terminal voltage falls until the set voltage of the unit with the second highest output voltage is reached. The second unit then delivers load current together with the first unit until an increase in load causes limiting to occur in the second unit. A further small voltage drop then occurs before the next unit delivers its share of the load current.

If the various output voltages are set so that their difference is less than the regulation of the units then generally all units will deliver some current to any load, but they may not necessarily current share. However, regardless of the voltage settings used, the

total change in output voltage from no load to full load (i.e. the sum of all unit current ratings) will be from the voltage of the highest set unit to the full load terminal voltage of the lowest set unit.

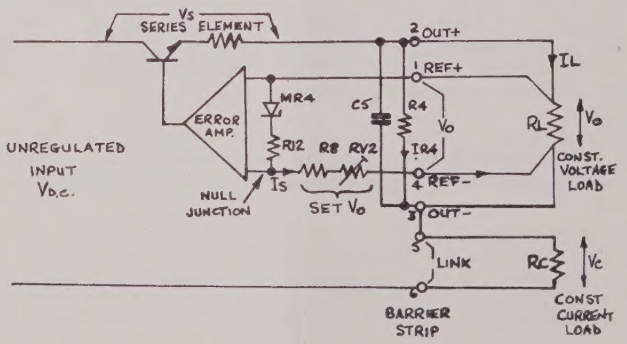
(b) Master-slave parallel operation.
In this method one unit designated the master controls the output voltage and the other units are connected to the master in such a way that they supply a current equal to that delivered by the master. This method demands slight wiring changes to the units, and furthermore suffers from the disadvantage that the units should be of the same type or at least compatible for this paralleling technique. Since the first method outlined is much simpler, and more widely used at present, details are available upon request.

(c) Common-point parallel operation.
In this method the point (A) on the printed circuit board of each unit is joined. This ensures an approximate sharing of current between the units. As in (B) not all types of unit can be used in parallel and an enquiry should be made before this method is used. However this method does have the advantage that if one unit fails the other units will not be affected.

11. Use of S & M Series Units for Constant Current.

These stabilised power supplies have been designed for use as constant voltage and constant current supplies. To change from one mode to the other involves basically only changes in the external connections to the output barrier strip; however, in constant current use there are some load conditions that may require a certain degree of caution on the part of the user if misleading results or damage to the unit is to be avoided. These conditions are dealt with later.

Outline of Operation.



The stabilised output voltage Vo appears across the REF terminals, and is sampled by R12, R8, RV2 and compared with the reference voltage across MR4 zener Diode. The current IS through R8, RV2, is substantially constant regardless of load or output voltage, and is usually about 3MA. The current flowing through the link is thus IR4 + IS + IL, IL being the current in the constant voltage load RL. The current IR4 is also substantially constant for a constant output voltage Vo. If now a further load Rc is inserted in place of the link, the current flowing does not change since IR4 + IS + IL is determined mainly by R4, (R8 + RV2) and RL which are all fixed. The unit therefore acts as a constant current supply delivering its output from the LINK terminals. The load RL is usually chosen to drop about 1 volt, and the voltage output V out is set up to this value. The output voltage control RV2 then affords a convenient means of adjusting the current.

PRECAUTIONS

(1) Note that the minimum constant current is IR4 + IS when RL is open circuit. This may be reduced to IS by removing R4 from the barrier strip, but this also removes the main off load discharge path for C5, and may slightly degrade the performance in constant voltage use since the off load D.C. conditions will be altered.

(2) Note that the maximum voltage Vc available for the constant current load inserted in the LINK position is VDC– VS– Vo. If VDC is adjusted by means of the transformer tappings to just give the required Vc at a mains input nominal – 10%, then the series element can safely accommodate the changes in Vs due to mains changes from 90% to 110% of nominal provided that Vc + Vo does not exceed the normal maximum output voltage rating for the unit. If however, the load Rc is reduced without adjustment of Vdc, the change in Vc also appears across the series element, and care must be taken that the maximum dissipation for the particular unit is not exceeded when the mains is at 110% of nominal. Under certain load condition the dissipation is within rating even when Vc falls to zero at maximum current, but this is not generally so.

(3) If the constant current load is inductive, a suitable diode should be connected across the link so that under normal current flow it is not conducting. This should prevent damage due to inductive surge.

(4) Occasionally it may be necessary to place a capacitor across the constant current load to prevent ascillation occurring.

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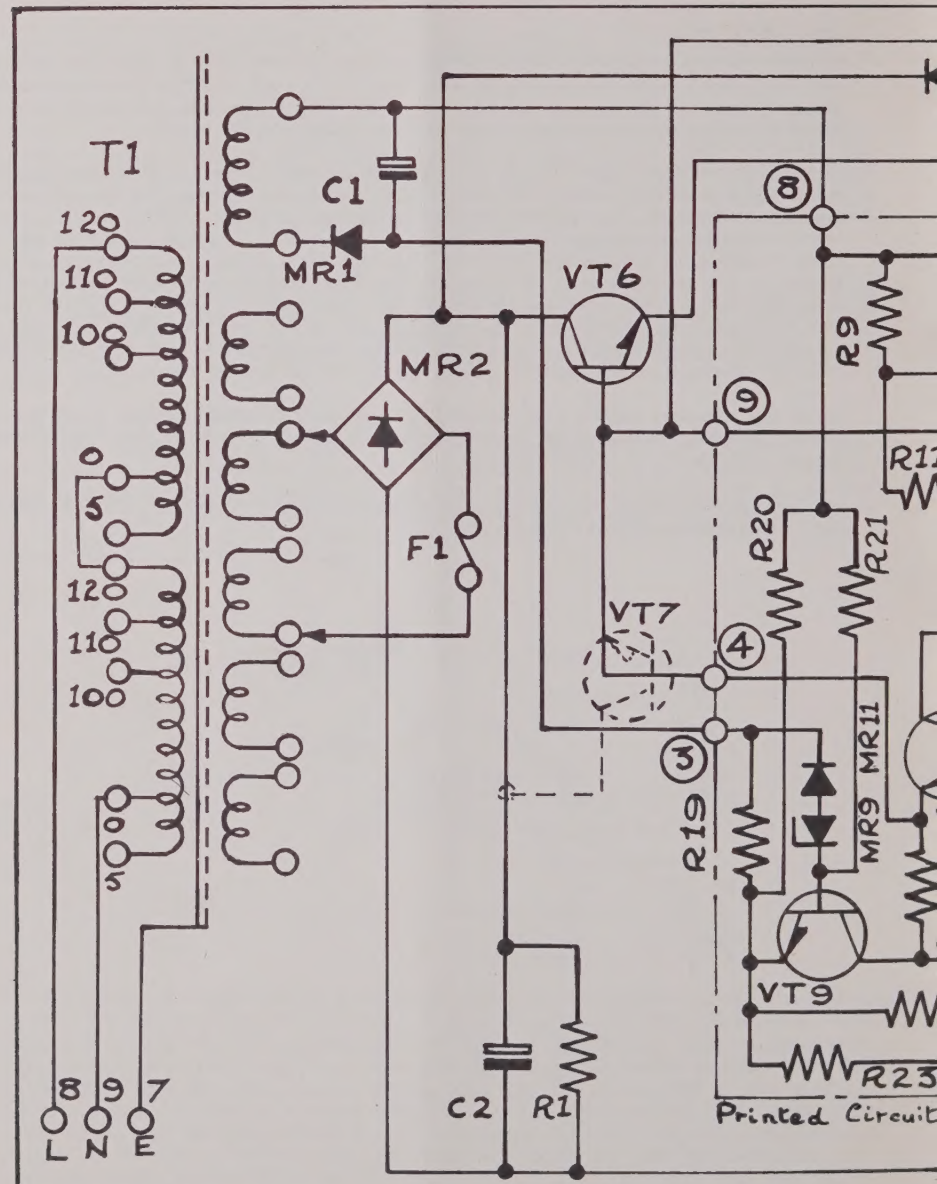
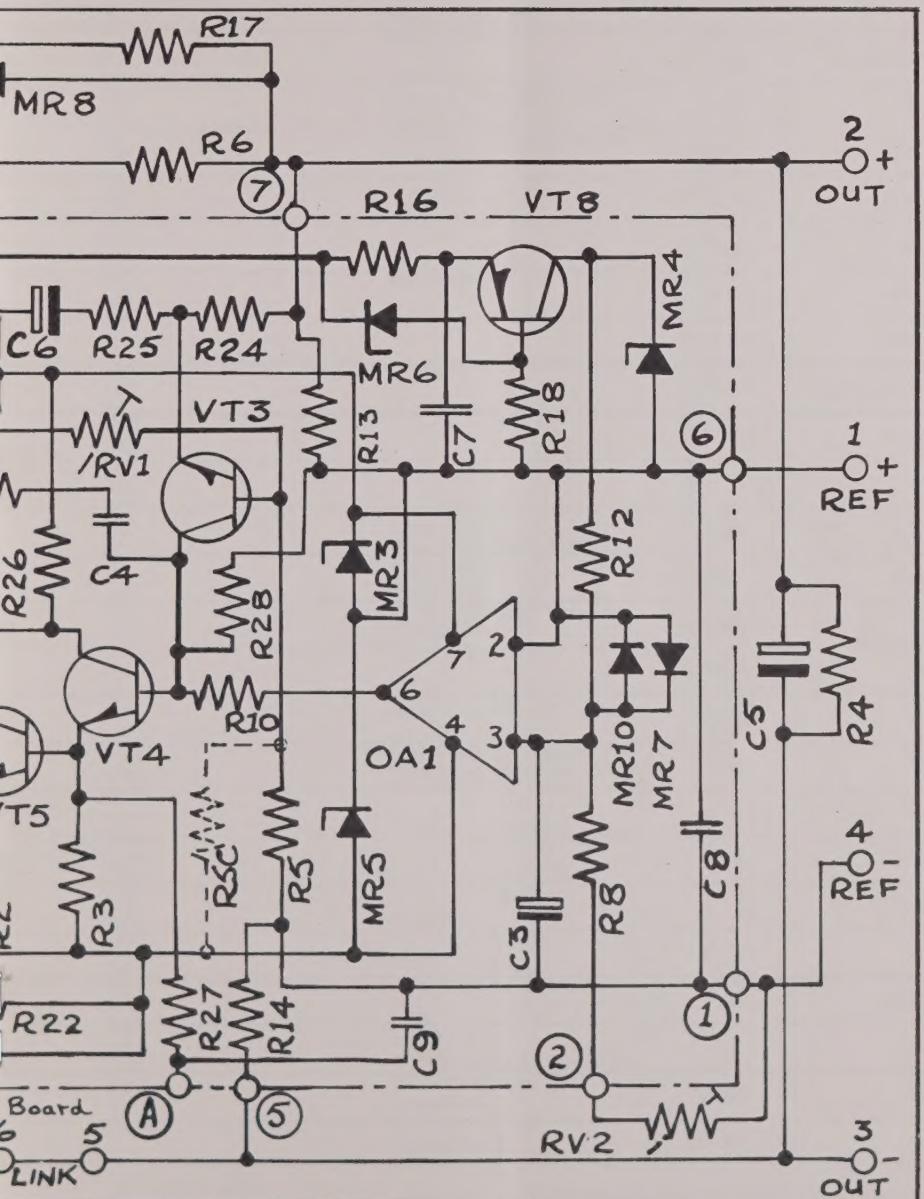


Note(i) VT7 Fitted on units above 1·5 amps output

Note(ii) on twin units of 4" width Connection Connections


R17
MR8
R6
7
R16
VT8
2
+
OUT
C6
R25
R24
MR6
MR4
VT3
/RV1
R13
C7
R18
6
1
+
REF
R26
C4
R28
MR3
R12
R10
VT4
OA1
MR10
MR7
C5
R4
T5
R3
RSC
R5
MR5
C3
R8
C8
4
REF
R22
R27
R14
C9
1
2
A
5
RV2
Board
6
5
LINK
3
OUT
1 & 4 are minature Sockets
3 & 5 are a single terminal

SETTING – UP VALUES OF RESISTANCE FOR S & M SERIES

OUTPUT VOLTAGE	R5
2 to 6	2.2K
6.1 ,, 15	5.6K
15.1 ,, 30	10 K
30.1 ,, 50	16 K
50.1 ,, 85	27 K
85.1 ,, 150	47 K
CONSTANT CURRENT	5.6 K
S UNITS ONLY	R8
0 to 6	0
6.1 ,, 11.5	1.8K
11.6 ,, 16.5	3.9K
16.6 ,, 20	5.6K
20.1 ,, 24	6.8K
24.1 ,, 28	8.2K
28.1 ,, 33	10 K Selected
33.1 ,, 38	12 K ,,
38.1 ,, 41.5	13 K ,,
41.6 ,, 46.5	15 K ,,
46.6 ,, 49	16 K ,, 18K above 49V
M UNITS ONLY	R8
0 to 50	0
50.1 ,, 100	18 K
100.1 ,, 150	39 K

GUIDE TO A.C. INPUT FOR D.C. OUTPUT
(A.C. MAY REQUIRE FINAL ADJUSTMENT TO MEET SPEC.)

$V_t = 0.9V_o + 5$

V_t = A.C. Secondary Volts on transformer

V_o = D.C. Output Volts.

ITEM	DESCRIPTION			
	2 Amps Output and above			
R1	Bleed Resistor			
R2	Resistance	3.9K	2%	½W
R3	”	10K	”	”
R4	Load Resistor			
R5	Current Setting Resistor			
R6	Series Resistor			
R8	Voltage Setting Resistor			
R9	Resistance	100	”	”
R10	”	2.2K	”	”
R11	”	1K	”	”
R12	”	2.2K	”	”
R13	”	100	”	”
R14	”	100	”	”
R16	Resistance	270	”	”
R17	”	100	”	”
R18	”	1.8K	”	”
R19	”	100	”	”
R20	”	10K	”	”
R21	”	8.2K	”	”
R22	”	820	”	”
R23	”	1K	”	”
R24	”	47	”	”
R25	”	1K	”	”
R26	”	220	”	”
R27	”	47	”	”
C1	Capacitor	100μF	64V	
C2	Reservoir Capacitance			
C3	Capacitor	5μF	64V	
C4	Capacitor	0.1μF	250V	
C5	Output Capacitance			
C6	Capacitor	100μF	12V	
C7	Selected on Test			
C8		0.01μF	250V	
C9		0.01μF	250V	
RV1	Potentiometer	1K		
RV2	”	2.5K		
OA1	Operational Amplifier	741		
VT3	Transistor BC 108			
VT4	” ”			
VT5	” ”			
VT6	” 2N3055			
VT7	” ”			
VT8	” BCY 70			
VT9	” BFY 51			
MR1	Rectifier	10D2		
MR2	” Bridge			
MR3	Zener Diode	VR9F		
MR4	” ”	1N823		
MR5	” ”	VR9F		
MR6	” ”	1S2033A		
MR7	Rectifier	10D2		
MR8	VT6 Protection Rectifier			
MR9	Zener Diode	1S2062A		
MR10	Rectifier	10D2		
MR11	”	”		
T1	Transformer			
“M” Units Only				
C3	Capacitor	6μF	150V	
RV2	Potentiometer	25K		
VT6 & VT7	Transistor	2N3442 for M10		
” ”	”	40313 ” M15		

Note For units of 1½ amps and below VT7 and R17 are not used.

70 mA
67 mA.

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